National Park Service
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Natural Resource Stewardship and Science

Mount Rainier National Park and Olympic National Park Elk Monitoring Program Annual Report 2010

Natural Resource Data Series NPS/NCCN/NRDS—2011/289

ON THE COVER
Elk, *Cervus elaphus* Mount Rainier, August 2010.
Photo: NPS I&M program

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September, 2011

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on a protocol that is currently in peer review, and were analyzed and interpreted within the guidelines of that protocol.

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This report is available from the North Coast and Cascades Network Inventory and Monitoring website (http://science.nature.nps.gov/im/units/nccn/reportpubs.cfm) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

Please cite this publication as:

Griffin, P. C., P. J. Happe, K. J. Jenkins, M. Reid, D. Vales, B. J. Moeller, M. Tirhi, S. McCorquodale, and P. Miller. 2011. Mount Rainier National Park and Olympic National Park elk monitoring program annual report 2010. Natural Resource Data Series NPS/NCCN/NRDS—2011/289. National Park Service, Fort Collins, Colorado.

NPS 105/109945, 149/109945, September 2011

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Executive Summary

Fiscal year 2010 was the third year of gathering data needed for protocol development while simultaneously implementing what is expected to be the elk monitoring protocol at Mount Rainier (MORA) and Olympic (OLYM) national parks in the North Coast and Cascades Network (NCCN). Elk monitoring in these large wilderness parks relies on aerial surveys from a helicopter. Summer surveys are planned for both parks and are intended to provide quantitative estimates of abundance, sex and age composition, and distribution of migratory elk in high elevation trend count areas. Spring surveys are planned at Olympic National Park and are intended to provide quantitative estimates of abundance of resident and migratory elk on low-elevation winter ranges within surveyed trend count areas.

An unknown number of elk is not detected during surveys. The protocol under development aims to estimate the number of missed elk by applying a model that accounts for detection bias. Detection bias in elk surveys in MORA will be estimated using a double-observer sightability model that was developed based on data from surveys conducted in 2008-2010. The model was developed using elk that were previously equipped with radio collars by cooperating tribes. That model is currently in peer review. At the onset of protocol development in OLYM there were no existing radio- collars on elk. Consequently double-observer sightability models have not yet been developed for elk surveys in OLYM; the majority of the effort in OLYM has been focused on capturing and radio collaring elk to permit the development of sightability models for application in OLYM. As a result, no estimates of abundance or composition are included in this annual report, only raw counts of the numbers of elk seen in surveys.

At MORA each of the two trend count areas (North Rainier herd, and South Rainier herd) were surveyed twice. 290 and 380 elk were counted on the two replicates in the North Rainier herd, and 621 and 327 elk counted on the two replicate South Rainier counts.

At Olympic National Park, each of three spring trend count areas was surveyed once in March 2010. 27 elk were observed in the South Fork Hoh trend count area, 137 elk were observed in the Hoh trend count area, and 131 elk were observed in the Queets trend count area. In September 2010, 18 elk were captured and fitted with radio collars as part of a contracted animal capture, eradication and tagging of animals (ACETA) operation. These animals will be available to contribute double-observer sightability data in future spring and summer surveys. There were no summer surveys for elk in OLYM in 2010.

Acknowledgments

Elk monitoring in Mount Rainier National Park and Olympic National Park is a component of the North Coast and Cascades Network (NCCN) of National Parks Inventory and Monitoring (I&M) Program (Weber et al. 2009). The program in FY2010 was supported by the NCCN I&M program and was also supported by Muckleshoot Indian Tribe (MIT), Puyallup Tribe of Indians (PTOI), Washington Department of Fish and Game (WDFW), Mount Rainier National Park (MORA), Olympic National Park (OLYM), U.S. Geological Survey, and the Washington National Parks Fund. The Lower Elwha K'lallam Tribe (LEKT) supported some elk capture operations in OLYM. The National Park Service is grateful to the Muckleshoot Indian Tribe (MIT), Puyallup Tribe of Indians (PTOI), and Washington Department of Fish and Wildlife (WDFW), which have long supported elk monitoring in Mount Rainier National Park, and have been full partners in the development and implementation of the monitoring protocol. Each of these partners contributed substantial funding and personnel in support of aerial surveys, as well as experience and ideas critical to developing and testing the protocol for elk monitoring in these parks. The authors thank the other crew members who participated in surveys including Kathy Beirne, Bill Baccus, Alyssa Herr, Rebecca Lofgren, Rich Lechleitner, Julie Okita, Glenn Kessler (NPS); Mike Middleton, Mike Hilden (MIT); Paul Arnold, Don Coats (PTOI); Sandra Jonker, Eric Holman, Tammi Schmidt (WDFW). We thank the following pilots and animal capture crew for their assistance: Doug Uttecht, Jess Hagerman, Trevor Walker (Northwest Helicopters); Curt Cousins (Olympic Air); Jim Pope, Mike Atchison, Wes Livingston, and Grant Cadwallader, (Leading Edge Aviation); Jeannie Ross, D.V.M. We are also grateful for the assistance leant by Vectronic Aerospace GmbH who readily replaced malfunctioning radio collars and provided funds to support additional captures in OLYM. For their support of the elk monitoring program, we thank Muckleshoot Indian Tribe Wildlife Committee (MIT); Phillip Dillon (PTOI); and Kim Sager-Fradkin (LEKT), Paul Geissler, (USGS Status and Trends Program). We are grateful to Douglas Houston, Robert Kuntz and Greg Shirato for reviews of the draft report.

Introduction

Elk populations are key components of lowland and montane ecosystems in Mount Rainier National Park (MORA) and Olympic National Park (OLYM), and are tightly woven into each park's historical and cultural fabrics. Historical accounts indicate Roosevelt elk (*Cervus elaphus roosevelti*), the Pacific coastal subspecies of elk, were abundant in primeval floodplains and riparian forests along many of the major river systems in western Washington and during summer many herds migrated to subalpine meadows of adjoining mountain chains (Schwartz and Mitchell 1945, Starkey et al. 1982, Taber and Raedeke 1980). Although the ethnographic record clearly indicates that elk were hunted by Native Americans and indigenous to both the Olympic and Cascades Ranges, early distribution patterns of elk in the Cascades are poorly understood. It is widely acknowledged that elk had become quite rare or absent around Mount Rainier in early historical times for reasons that are not known (Gustafson 1983, Schullery 1983). By the start of the 20th century, unregulated market hunting of elk for meat, antlers, and trophy 'ivory' teeth had widely decimated elk populations throughout the most accessible and settled areas of Oregon and Washington (Graf 1955, Murie 1951). A notable exception was on the Olympic Peninsula where a largely inaccessible wilderness helped to protect a remnant stronghold of native Roosevelt elk.

Elk in Mount Rainier National Park

MORA was created in 1899 to preserve natural wonders of the volcano (Mount Rainier) and its surroundings, and to protect fish and game (U.S. Congress 1899). Because the park was established largely to protect the mountain, it encompasses mostly montane forests and high elevation subalpine and alpine environments used by elk as summer ranges, but not the majority of low-elevation winter ranges in the adjoining river valleys. Although the native elk had been largely, if not completely eliminated from MORA by 1899, elk populations were reestablished through several translocations of Rocky Mountain elk (*Cervus elaphus nelson*i) from Yellowstone and Grand Teton national parks to lands adjacent to the park in 1912-1915 and 1932-1933 (Bradley 1982). Wildlife observation cards maintained at MORA and summarized by Bradley (1982) indicated that by 1915 elk were observed in Grand Park (i.e. the northern part of MORA) just a couple of years following the first releases, and that by the 1930's they had dispersed widely to inhabit the primary summer ranges used by elk today.

From 1950 to the 1970's intensive logging of elk winter ranges adjoining MORA improved winter and spring foraging conditions for elk and stimulated population growth of migratory elk herds that wintered adjacent to the park and summered within (Raedeke and Lehmkuhl 1985, Jenkins and Starkey 1996). In 1962, a U.S. Forest Service biologist counted 466 elk on subalpine meadows within MORA, prompting initial concerns over the potential impacts of elk on subalpine meadows, one of the park's premier natural resources. As elk populations continued to grow during the 1970's and signs of trailing, trampling, and grazing impacts drew greater attention, the following questions assumed primary importance to park managers (Starkey 1984): (1) are the elk native to the park, (2) is the elk population growth a natural ecological process, (3) what changes can be expected into the future, and (4) are the elk having lasting impacts on subalpine vegetation? As a direct response to these growing management concerns, the NPS and several university research cooperators conducted studies of elk history and ethnography in the Mount Rainier ecosystem (Bradley 1982, Gustafson 1983, Schullery 1983), elk distribution and ecology (Bradley 1982, Cooper, 1987), elk taxonomy (Shoenwald-Cox 1983), land-use and forest succession on winter range (Jenkins and Starkey 1996), and grazing and trampling impacts

on subalpine summer ranges (Bradley 1982, Ripple et al. 1988, Motazedian and Sharrow 1984, Sharrow and Kuntz 1986). Primary conclusions of this collective work were that elk were native to the area (Gustafson 1983), and that subspecific differences in the Rocky Mountain elk that were reintroduced near the park were not sufficiently distinctive to consider the present population non-native or exotic (Shoenwald-Cox 1993, Starkey 1984). It was concluded that elk populations using the park during summer are influenced by logging practices on adjoining winter ranges, but that post-logging forest succession patterns had reduced forage availability on the winter range and ameliorated population growth trends by the late 1980's (Jenkins and Starkey 1996). Although trailing and trampling impacts were locally important (Bradley 1982, Ripple et al. 1988), grazing impacts were not clearly demonstrated (Sharrow and Kuntz 1986). Because elk are such important drivers of ecosystem change, however, it was suggested that long-term monitoring of both subalpine vegetation and elk populations should be sustained indefinitely (Starkey 1984).

Elk in Olympic National Park

OLYM was created first as Mount Olympus National Monument in 1909 by Theodore Roosevelt for the explicit purpose of protecting the last stronghold of Roosevelt elk and its native forested habitat following the large-scale decline in elk populations. Although elk were very abundant throughout the Olympic Peninsula in early historical times, by the turn of the century only 3,000 remained, primarily in the central core of the Peninsula that is currently OLYM (Morganroth 1909). Mount Olympus National Monument was expanded and re-created as OLYM in 1938 to "provide suitable winter range and permanent protection for herds of native Roosevelt elk" (U.S. Congress 1938). Because elk were central to the creation of the park, its boundaries represent as complete an ecological system as was possible when the park was created, including both subalpine summer ranges of elk in the park's mountainous interior, and the many low-elevation river valleys used as winter range. Today the park is internationally recognized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as a Biosphere Reserve and a World Heritage Site.

The creation of Mt. Olympus National Monument was just one of several coordinated measures to protect dwindling elk herds throughout Washington at the turn of the last century. In addition to the efforts to restock former big game ranges in other areas of the state (i.e., the Mount Rainier ecosystem), elk were protected through a moratorium on hunting, and through an aggressive campaign against predators. A bounty was placed on wolves and cougars, which reduced predation on elk, and ultimately led to the eradication of wolves on the Olympic Peninsula by the late 1920's (Scheffer 1949).

Elk populations responded favorably to multifaceted protection on the Olympic Peninsula. As early as 1915, there were reports of 'overbrowsing' in the western rainforest valleys of the Mt. Olympus National Monument, and large numbers of elk were reported dying during severe winters (Schwartz 1939). During the 1930's, several U.S. Forest Service and NPS biologists examined elk ranges throughout the park and reported concerns about overgrazing in low-elevation winter ranges within the temperate rainforests (Murie 1935*a*, Murie 1935*b*, Sumner 1938, Schwartz 1939). Twenty years later, Newman (1958) noted that the range was not severely over used and that the elk population was stable because of the "rapid and regular seasonal growth of forage plants, even pressure from predators, and natural die-offs".

Elk continue to play an important ecological role in both MORA and OLYM – as architects of plant communities, drivers of ecosystem processes, and sustainers of diverse communities of predators and scavengers. In addition to these important ecological roles in the ecosystem, elk in both parks are significant to hundreds of thousands of visitors annually who travel to these parks with the hope of viewing elk in their natural environment.

Land use, hunting, and predator management programs on lands adjacent to these parks have the potential to influence elk population trends and ecosystem dynamics within the parks. Information on ungulate population trends has important management significance in North Coast and Cascades Network (NCCN) parks through its influence on internal park management decisions, and the ability of the NPS to work effectively with land and wildlife managing agencies and local Native American Tribes in establishing common management goals and objectives outside the park's boundaries. Furthermore, interpreting the status, trends, and ecological significance of park resources to an interested public is an important function of the National Park Service.

Monitoring Objectives

There are two specific objectives of the MORA and OLYM elk monitoring protocol.

> **Objective 1**: Monitor trends in elk abundance, distribution, and composition in selected subalpine summer ranges in MORA and OLYM.
>
> **Objective 2**: Monitor trends in elk abundance and distribution in selected low-elevation winter ranges in OLYM.

2010 was the third year of protocol development. Data collection methods in 2008 - 2010 conformed to those in the protocol (Griffin et al. in review). Consequently these three years of data contributed to both an early start of data collection for the implementation phase of the monitoring program and the development of the double-observer sightability model for MORA surveys (Griffin et al. in review). Similarly, data collected in the last three years in OLYM will contribute to development of sightability models for OLYM spring and summer surveys. Capturing and radio-collaring elk in OLYM has been centrally important for sightability model development in OLYM. Once the model is developed the OLYM data can be retroactively analyzed to correct raw counts for detection biases.

This report and subsequent annual reports for the MORA and OLYM elk monitoring program are for administrative purposes; data are summarized and presented without extensive analysis or interpretation. Future annual reports will include estimates of abundance and composition for surveys for which there is an applicable model to account for detection bias. However, there are no estimates of abundance or composition in this report as we are awaiting peer review of the double-observer sightability model for MORA summer surveys (Griffin et al. in review), and such a model has not yet been developed for OLYM spring or summer surveys. Every four years we will provide reports that contain more comprehensive analysis of the data, including quantified estimates of variance and trends, and interpretation of those data. The next four-year report is expected to be completed in conjunction with the annual report for 2012. By that time, we anticipate that the double-observer sightability model for MORA summer surveys and the rest of the draft protocol (Griffin et al. in review) will have been approved and published.

Study Area

In MORA, the two trend count areas include all of the subalpine habitats in the park that are encompassed by an arc around the volcano from Vernal Park in the north, to Chinook Pass at the east, and south through the Tatoosh Range (Figure 1). These trend count areas include the primary subalpine summer ranges of the North Rainier Herd and South Rainier Herd.

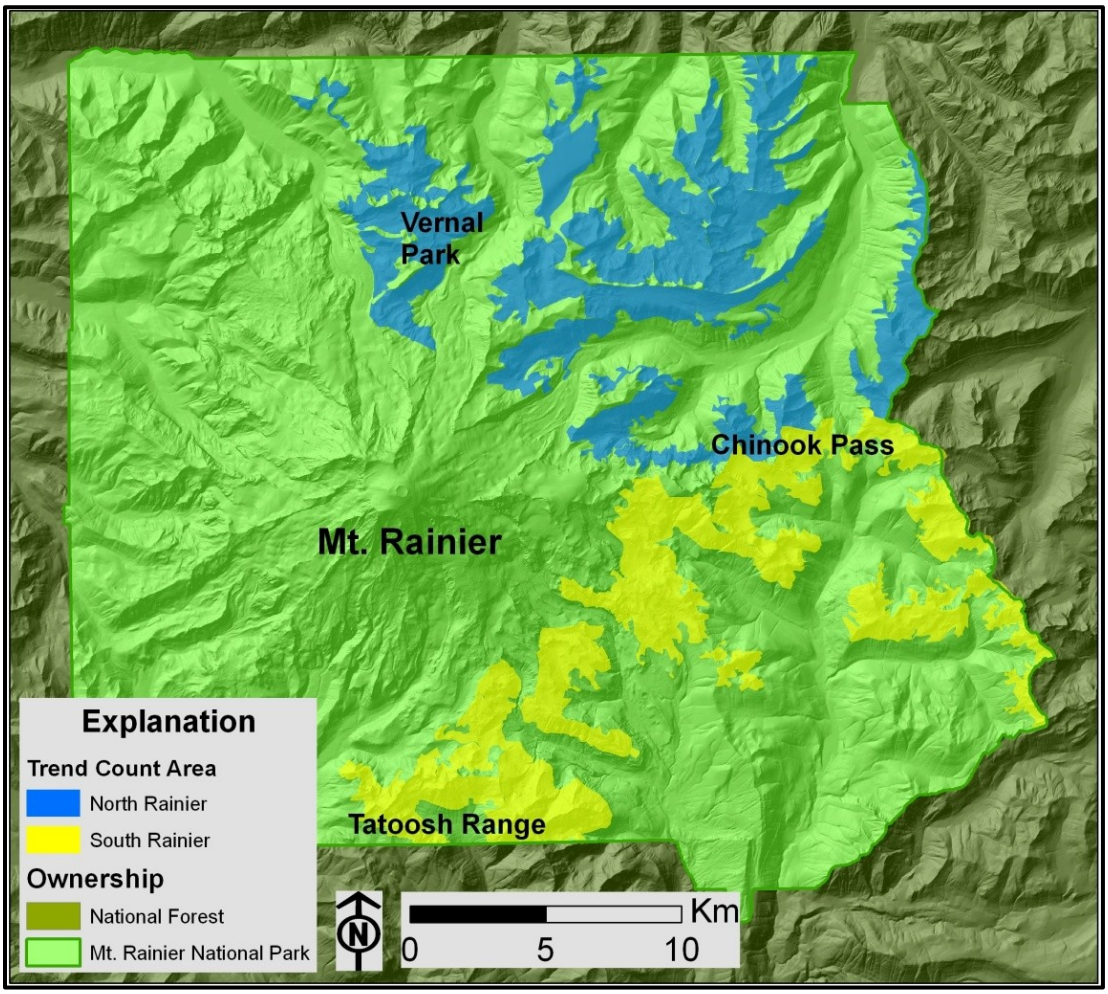

Figure 1. Summer trend count areas within MORA. The North Rainier trend count area is approximately 103 km^2, and the South Rainier trend count area is approximately 89 km^2.

In OLYM the majority of the summer range for migratory elk is divided into five trend count areas. The core area corresponds with summer range of migratory herds of elk that winter in the primary low-elevation winter ranges in the Hoh and Queets Valleys (Schwartz and Mitchell 1945, Olympic National Park, unpublished data). The four ancillary summer range trend count areas (Figure 2) encompass the majority of the remaining migratory elk populations in the Park. Elk in the Quinault, Elwha and Northwest trend count areas winter in OLYM, whereas elk in the Southeast migrate out of OLYM and winter near the Hood Canal.

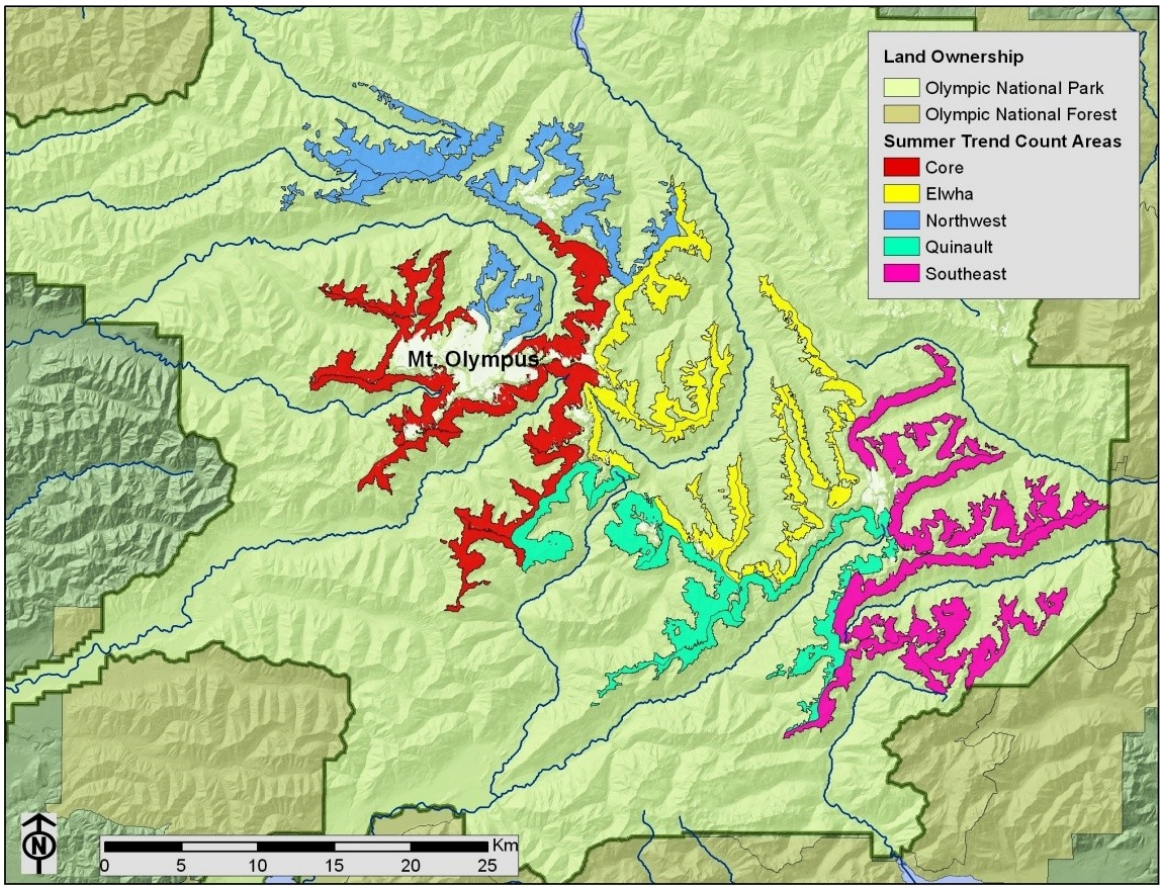

Figure 2. Summer trend count areas within OLYM, including the core trend count area that will be surveyed annually, and four ancillary trend count areas that will be surveyed once per four years. The Core, Elwha, Northwest, Quinault, and Southeast trend count areas are approximately 93, 82, 74, 80, and 85 km^2, respectively.

The spring OLYM trend count areas correspond with three key winter ranges selected on the basis of high relative densities of elk; the three watersheds collectively hold approximately half of all elk that winter in OLYM (Jenkins and Manly, 2008). These same watersheds are also the area of the park with the most historical elk monitoring and research on interactions between elk and vegetation (Jenkins and Starkey 1981, Jenkins and Starkey 1984, Happe 1993, Schroer et al. 1993, Schreiner et al. 1996, Woodward et al. 1994). Each of the key winter ranges is used year round by resident herds that remain in low elevation home ranges and by migratory herds that move from high elevation subalpine ranges in summer to low elevation ranges primarily during winter and early spring.

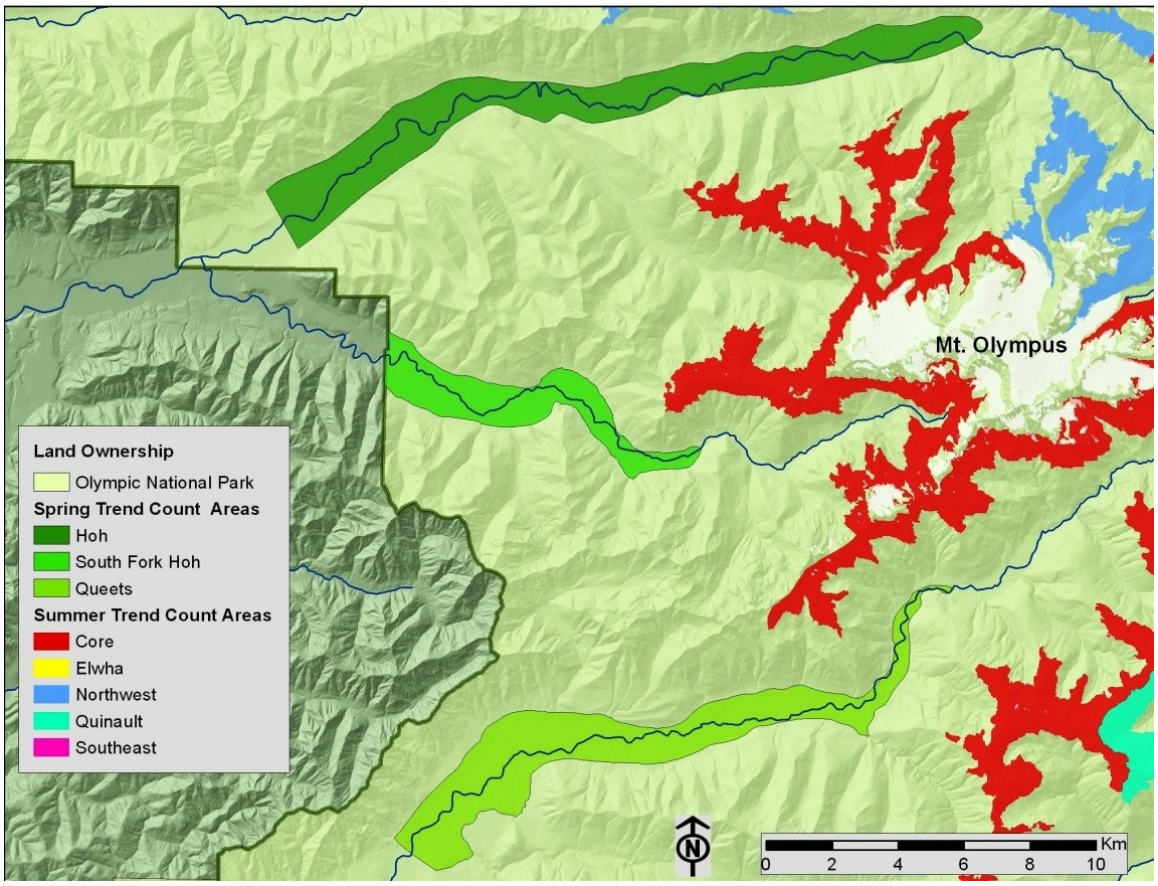

Figure 3. Map of the Hoh, South Fork Hoh, and Queets trend count areas for OLYM spring surveys. The Core summer trend count area, shaded in red, is shown for reference. The Hoh, South Fork Hoh, and Queets trend count areas are approximately 27, 11, and 24 km^2, respectively.

Methods

The sample design, survey methods, and analytical framework for elk monitoring are presented in detail in the elk monitoring protocol for MORA and OLYM (Griffin et al. in review). Salient features are summarized below.

Safety

All helicopter survey operations strictly followed specific helicopter use aviation safety plans, prepared specifically for each survey (Baccus 2010, Reid 2010). Elk capture and collaring operations at OLYM strictly followed the ACETA plan for that mission (Happe 2010).

Sample Design

Two trend count areas established in MORA (Figure 1) and five in OLYM (Figure 2) comprise most of the subalpine summer ranges used by elk in each park. We defined trend count areas on the basis of elevation and forest canopy cover. In MORA, trend count areas were bounded by elevations below 2100 m and above 1500 m in the North herd range, and by elevations below 2100 m and above 1350 m in the South Rainier trend count area, except that on the SW facing slopes of Stevens Ridge and Shriner Peak we surveyed down to 1200 m. In OLYM, summer trend count areas ranged between 1200 m and 1650 m.

Within the elevation boundaries of trend count areas, we used each park's vegetation cover map (Pacific Meridian Resources 1996) to identify and exclude areas of continuous dense forest canopy cover or rock and snow.

Trend count areas for OLYM spring surveys in the Hoh, South Fork Hoh, and Queets valleys include winter range below 500 m, where the valley is broad enough for safe helicopter flights at low altitudes above treetops, where elk concentrate use in the spring, and where tree canopy cover is low enough to detect elk (Houston et al. 1987, Jenkins et. al. 1999, Griffin et al. in review).

The sampling design calls for completing two replicate surveys of both trend count areas in MORA in the 4 hours before sunset and two trend count areas in OLYM in 4 hours after sunrise in OLYM, with all surveys in both parks completed between 15 August and 15 September. Spring surveys in OLYM are completed within 4 hours of sunrise during March, after green up has begun but before deciduous overstories begin to leaf out.

Survey Methods

A crew of a pilot and three observers counted elk from a type-III helicopter (i.e., a Bell 206B-3 or Hughes 500D). Trend count areas were thoroughly searched in their entirety for elk from approximately 150 m (500 feet) above ground level, with flight lines approximately 250-500 m apart. We recorded the location and group size of all elk groups detected, as well as other covariate data that may be related to detection probability. In-flight protocols for the double observer method required all observers to act independently in searching for and detecting elk groups. After reconciling which independent observers detected each observed group of elk, all observers collaborated in determining group size, composition and covariates of detected groups. An elk group was defined as one or more elk in close proximity. Any large group was photographed with a high resolution digital camera (Schoenecker et al. 2006); later, the group

size or composition data, or both, were updated if the photo yielded a more complete count. Additionally, to provide data for developing the double-observer sightability model, we determined if there were any radio-collared elk within each of the observed groups. Following the surveys, we then determined locations and covariate values for any radio-collared elk that were not detected during the survey. The complete set of detailed sampling protocols is provided in Griffin et al. (in review).

Data Management

Upon landing, the observers immediately reviewed all data forms and noted and corrected any discrepancies. The GIS Specialist downloaded helicopter flight lines to the NCCN computer server. In MORA, the tribal and WDFW biologists provided copies of their completed data forms, the associated GPS files for the helicopter flight path, and any photographs of large elk groups to the MORA project manager. After the flights the project manager, participating wildlife biologist, or technician examined the photos; if inspection of photos led to a revision for group size or composition, then the pertinent photos were annotated and saved, and changes made to the data forms.

After the protocol is peer-reviewed and published, the OLYM and MORA project managers will enter survey data into the project database. In FY10, a USGS liaison (P. Griffin) entered MORA survey data into an Excel file with data fields that correspond to the project database's design. After data were entered, quality review included verification, which entailed confirming that data in the database were accurate with respect to the field forms. There were also checks for data consistency, and confirmation that all data entered were within acceptable bounds; those steps of quality assurance will be achieved by automated queries in the final project database. After data quality review was complete, the data were shared with project participants from MIT, PTOI, and WDFW. All OLYM data were processed in a similar fashion by the OLYM project manager.

Data Analysis

We summarized data according to the template provided in Griffin et al. (in review). Results of surveys are presented here without detailed analysis or accounting for detection bias. Variance estimates, along with more complete analyses of spatial distribution, and trends in abundance and composition, will be part of the four-year analysis.

2010 Capture Operation in Olympic National Park

All 10 GPS radio collars that were placed on elk in 2009 failed shortly after deployment. Because data from radio-collared elk are critical for the development of a sightability model for elk in OLYM, resources in 2010 were again focused on elk capture and radio collar deployment. The radio collar manufacturer, Vectronic Aerospace GbdH, sent 12 new GPS radio collars to replace 10 faulty units, and also funded about half of the capture operation necessary to deploy those radio collars. An additional 3 collars were supplied by the Lower Elwha K'lallam Tribe, for use on elk in the park in the Elwha valley where our research and monitoring interests overlap.

Results

Names and Roles of Project Personnel

Patti Happe served as the Project Lead in this study, and also as the project manager for OLYM. Mason Reid served as the project manager for MORA. David Vales was the wildlife biologist for Muckleshoot Indian Tribe (MIT). Barbara Moeller was the wildlife biologist for Puyallup Tribe of Indians (PTOI). Michelle Tirhi and Pat Miller were the wildlife biologists for Washington Department of Fish and Wildlife (WDFW) Region 6 and Region 5, respectively. Other survey personnel that took part in spring and summer surveys are listed in Table 1.

Table 1. Observers that participated in elk surveys in 2010. Personnel are identified by the tribe or agency with which they are affiliated.

Affiliation	Names
NPS	Patti Happe, Mason Reid, Kathy Beirne, Bill Baccus, Alyssa Herr (survey crew members); Rebecca Lofgren, Rich Lechleitner, Julie Okita, Glenn Kessler (helicopter managers)
USGS	Paul Griffin
MIT	David Vales, Mike Middleton, Mike Hilden
PTOI	Barbara Moeller, Paul Arnold, Don Coats
WDFW	Sandra Jonker, Pat Miller, Scott McCorquodale, Eric Holman, Michelle Tirhi, Tammi Schmidt
Pilots and capture crew	Doug Uttecht, Jess Hagerman, Trevor Walker (Northwest Helicopters); Kurt Cousins (Olympic Air); Jim Pope, Mike Atchison, Wes Livingston, Coburn NoEar, (Leading Edge Aviation); Jeannie Ross, D.V.M.

Flight Statistics

Mount Rainier Summer Surveys

Flights at MORA included two complete surveys in each of the trend count areas, as well as some additional survey flights that targeted radio-collared animals (Table 2). The first complete survey of the North Rainier herd trend count area was conducted on 17 August 2010, and the second on August 25. The first complete survey of the South Rainier herd trend count area was conducted on August 18. We attempted a complete second count in South Rainier on August 26 but were prevented from completing the flights due to severe winds; the South Rainier flights were completed on September 1 and September 2. We conducted an additional evening of surveys at MORA on 19 August and 2 September in order to increase the number of sightability trial data points.

Table 2. Flight details for summer 2010 survey flights at Mount Rainier National Park, Pilots' last names are in bold font.

Flight	Date	Replicate	Survey Units	Total flight	Survey time	Sponsor[1]	Crew Members
1	Aug 17	First North	N1,N2,N3a,N3b,N3c,N5a,N9,N10,N18, N17,N16b,N16a,N15	2 h 9 min	1 h 54 min	WDFW	**Hagerman**, Tirhi, Schmidt, Vales
2, 3	Aug 17		N6,N5b,N8a,N8b,N7,N11a,N11b,N4, N12a,N12b,N13a,N13b,N14	2 h 50 min	2 h 21 min	NPS	**Walker**, Reid, Beirne, Griffin
4	Aug 18	First South	S4,S1,S5b,S5a,S9,S7,S6,S19,S20, S18,S17	3 h 5 min	2 h 45 min	WDFW	**Hagerman**, Holman, Jonker, McCorquodale
5, 6	Aug 18		S16,S15,S14,S13,S11,S10,S8	3 h 15 min	2 h 27 min	NPS	**Walker**, Reid, Beirne, Griffin
7, 8[2]	Aug 19	Trials2	N8b,N8a,N3a,N2,N3b,N3c,N13a, N13b,N14	2 h 44 min	2 h 19 min	NPS/USGS	**Walker**, Reid, Beirne, Griffin
9, 10	Aug 25	Second North	N1,N2,N3a,N3b,N3c,N5a,N6,N9,N10, N18,N17,N16b,N16a,N15	3 h 20 min	2 h 47 min	USGS	**Walker**, Reid, Beirne, Griffin
11	Aug 25		N5b,N14,N13b,N13a,N12b,N12a, N11b,N11a, N7,N8b,N8a,N4	3 h 31 min	2 h 56 min	MIT	**Hagerman**, Vales, Middleton, Hilden
12	Aug 26	Second South	S16,S15,S14,S13,S11,S10,S8	2 h 24 min	2 h 2 min	PTOI	**Cousins**, Moeller, Arnold, Coats
13,14	Sept 1		S17,S4,S5a,S5b,S9,S5,S4,S1,S6,S7	2 h 12 min	1 h 31 min	USGS	**Walker**, Reid, Beirne, Hess
16[3]	Sept 2		S20,S19,S18	1 h 15 min	1 h 5 min	USGS	**Walker**, Reid, Beirne, Griffin
15, 16[2,4]	Sept 2	Trials2	N8b,N12b,N12a,N13a,N13b,N14	2 h 03 min	1 h 39 min	USGS	**Walker**, Reid, Beirne, Griffin

[1] Sponsors are the Tribe or agencies responsible for funding the helicopter costs.

[2] These flights primarily were flown to increase the sample size of sightability trial data points.

[3] Survey units S18, S19, and S20 from flight 16 were part of the second South herd survey.

[4] The portion of flight 16 in North herd survey unit N8b is listed with flight 15.

Olympic National Park Spring Surveys

Spring survey flights at OLYM were conducted on March 19 in the South Fork Hoh trend count area, March 20 in the Hoh trend count area, and March 24 in the Queets trend count area (Table 3). Weather and phenological conditions during the survey flights were within the guidelines in the protocol.

Table 3. Flight details for spring 2010 survey flights at Olympic National Park. Pilots' last names are in bold font. Costs of all these flights were paid by NPS.

Flight	Date	Trend Count Area	Total flight	Survey time	Crew Members
1	March 19	South Fork Hoh	1 h 25 min	57 min	**Uttecht**, Griffin, Baccus, Beirne
2, 3	March 20	Hoh	3 h 50 min	2 h 51 min	**Uttecht**, Happe, Baccus, Beirne
4, 5	March 24	Queets	3 h 57 min	2 h 56 min	**Uttecht**, Happe, Baccus, Beirne

Olympic National Park Summer surveys

Because we needed to allocate funding resources needed to complete elk capture operations, we did not conduct aerial surveys in Olympic National Park during summer 2010.

Elk Observations

Mount Rainier National Park Summer Surveys

Figures 4 through 7 show the flight survey paths (flight lines) flown during the summer surveys in MORA. Observed counts of elk groups in MORA are summarized in Table 4.

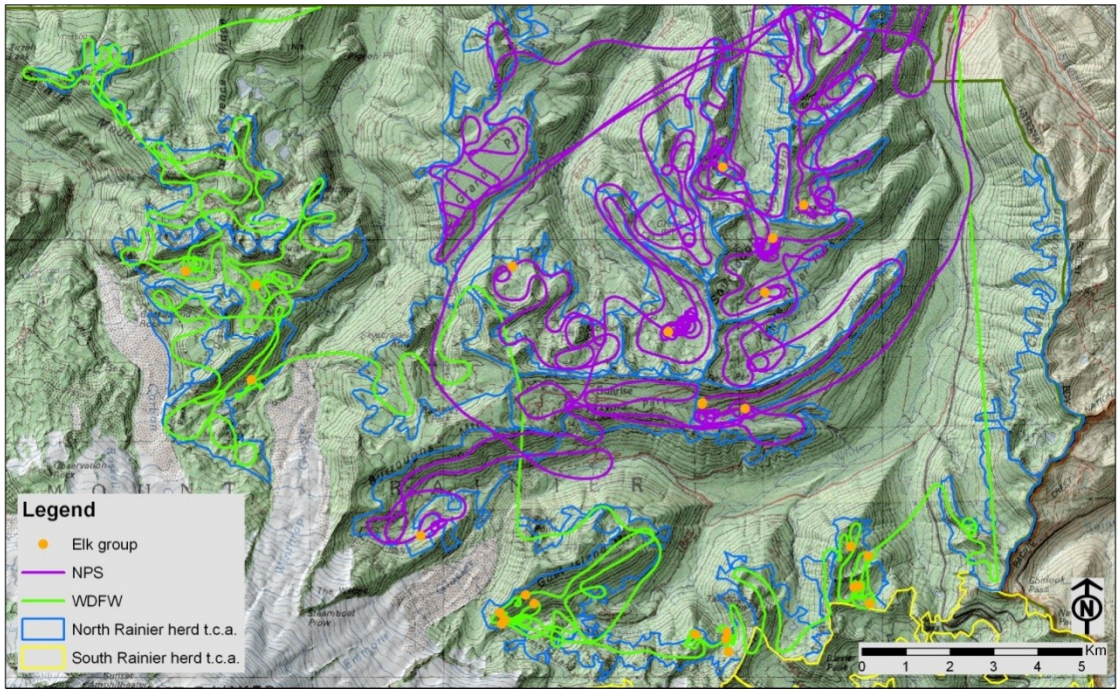

Figure 4. Flight lines for the first replicate survey in the North Rainier trend count area, conducted August 17, 2010. Blue lines indicate the boundaries of survey units. Purple lines indicate the flight lines for federally funded helicopter. Green lines indicate the flight line for the WDFW funded helicopter. Approximate locations of observed elk groups are indicated as orange circles.

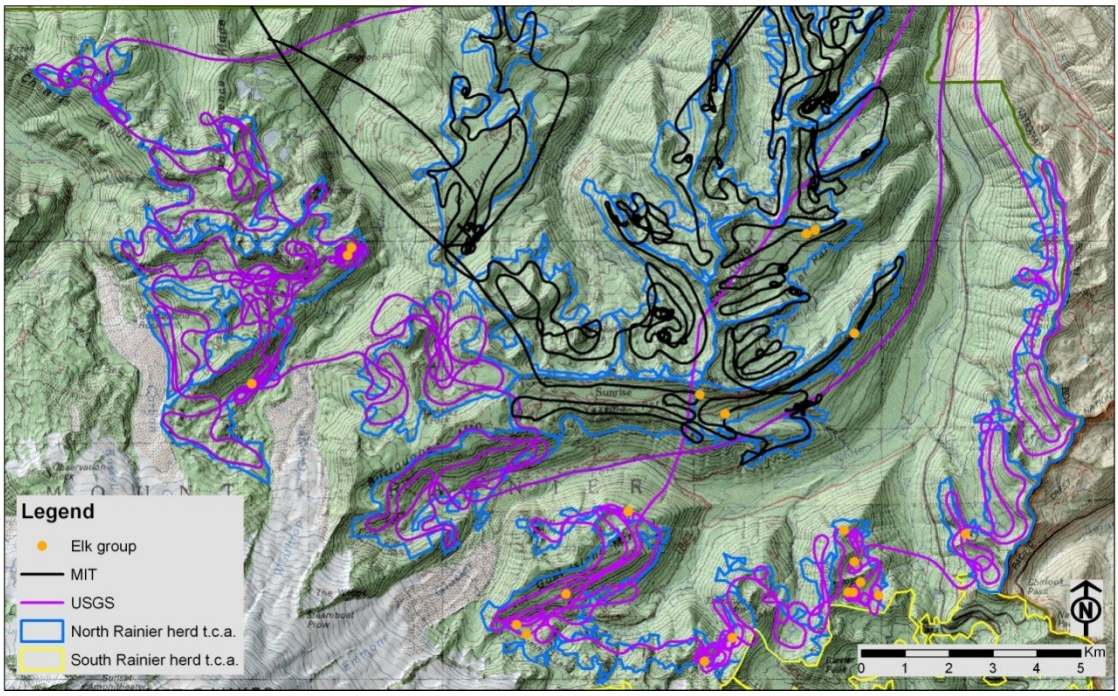

Figure 5. Flight lines for the second replicate survey in the North Rainier trend count area, conducted August 25, 2010. Blue lines indicate the boundaries of survey units. Purple lines indicate the flight lines for federally funded helicopter. Black lines indicate the flight line for the MIT funded helicopter. Approximate locations of observed elk groups are indicated as orange circles.

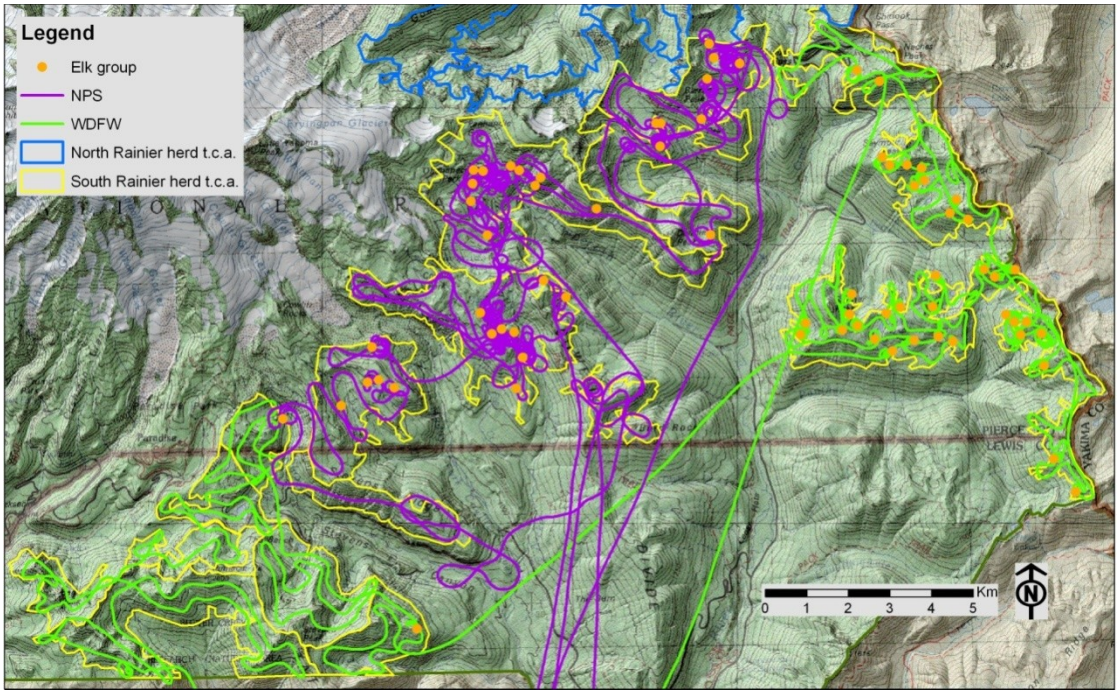

Figure 6. Flight lines for the first replicate survey in the South Rainier trend count area, conducted August 18, 2010. Yellow lines indicate the boundaries of survey units. Purple and green lines indicate the flight lines for the federally-funded and WDFW-funded helicopters, respectively. Observed elk groups are indicated as orange circles.

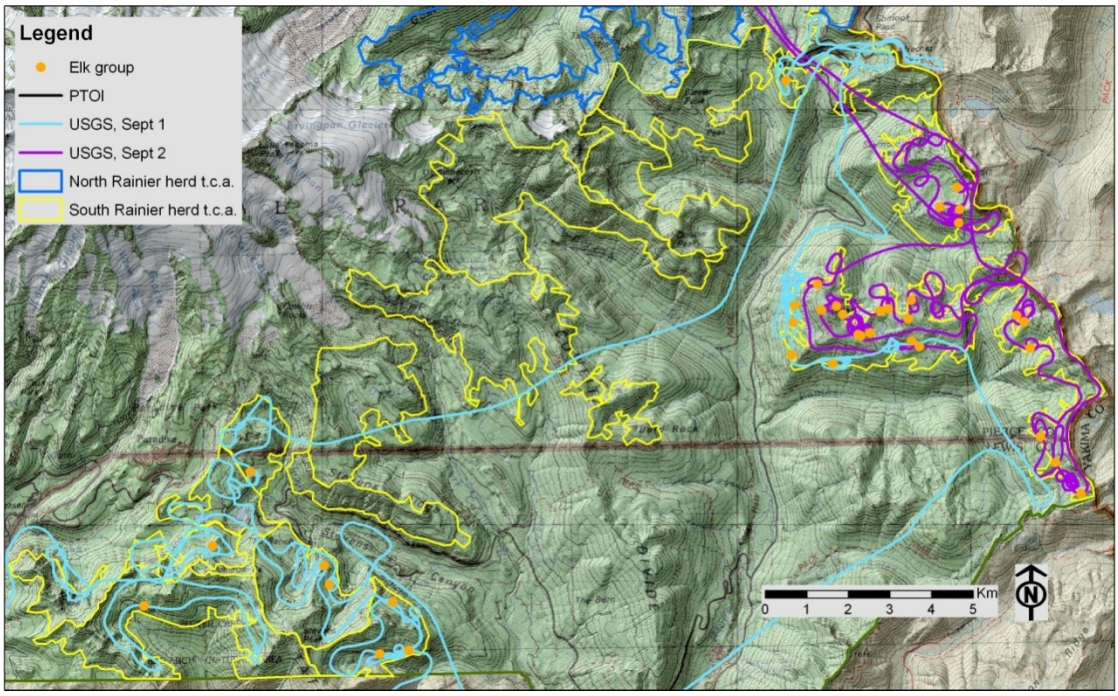

Figure 7. Flight lines for the second replicate survey in the South Rainier trend count area, conducted August 26, September 1 and September 2, 2010. Yellow lines indicate survey unit boundaries. The light blue line and purple lines indicate the federally-funded flights. Approximate locations of observed elk groups are indicated as orange circles. The PTOI-funded flight surveyed the remaining South Rainier herd survey units. Flight line and elk group locations for the PTOI-funded flight are not currently available for mapping. Approximate locations of observed elk groups are indicated as orange circles.

Table 4. Summarized elk observations from two replicate surveys of the North Rainier herd trend count area, and two replicate surveys of the South Rainier herd trend count area. These results include four elk groups that were not observed during the visual search portion of the surveys, but which were found via radio telemetry immediately after the surveys (three such groups in 1st North Rainier replicate, one such group in 2nd North Rainier replicate. They do not include three elk groups from the 2nd North Rainier survey, that were not seen during the visual search portion of the survey, and for which group size was not determined.

Trend Count Area	Groups	Total Elk	Cows	Calves	Bulls	Calves per 100 Cows	Bulls per 100 Cows	Mean Group Size	Max. Group Size
1st North Rainier	28	290	163	55	68	33.7	41.7	10.4	132
2nd North Rainier	35	380	177	89	69	50.3	39.0	11.9	132
1st South Rainier	71	621	349	111	103	31.8	29.5	8.7	85
2nd South Rainier	53	327	175	69	82	39.4	46.9	6.2	91

Olympic National Park Spring Surveys

Figures 8 through 10 show the flight paths flown during the spring surveys in OLYM. Observed counts of elk groups seen in OLYM spring surveys are summarized in Table 5.

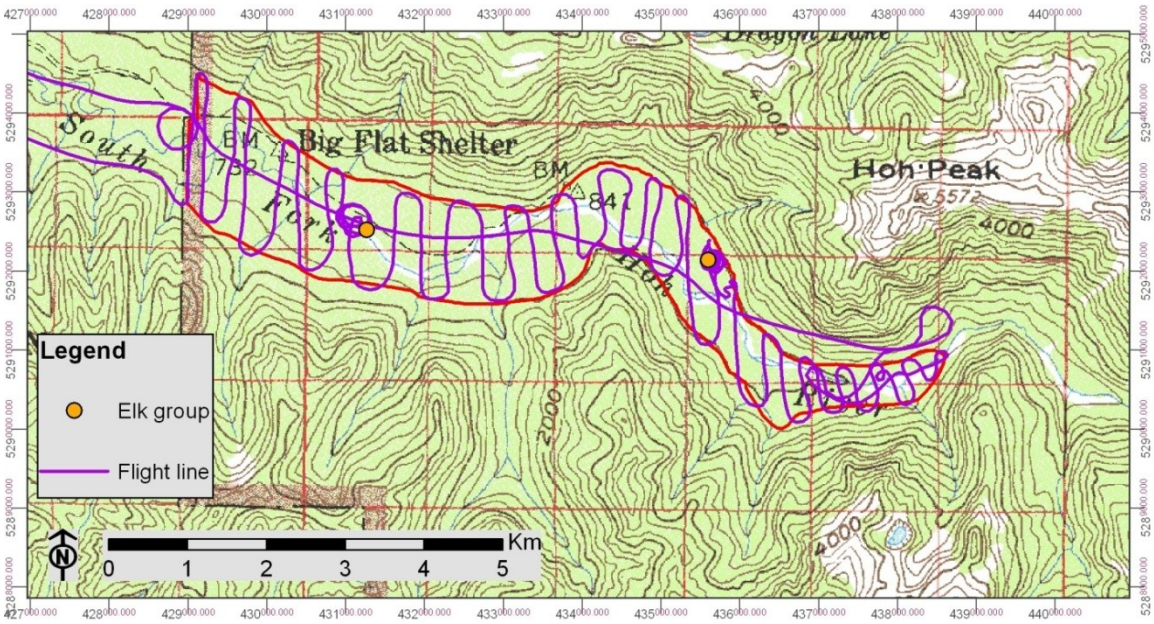

Figure 8. Flight line (purple) in the South Fork Hoh trend count area (red boundary line), conducted March 19, 2010. Approximate locations of observed elk groups are indicated as orange circles.

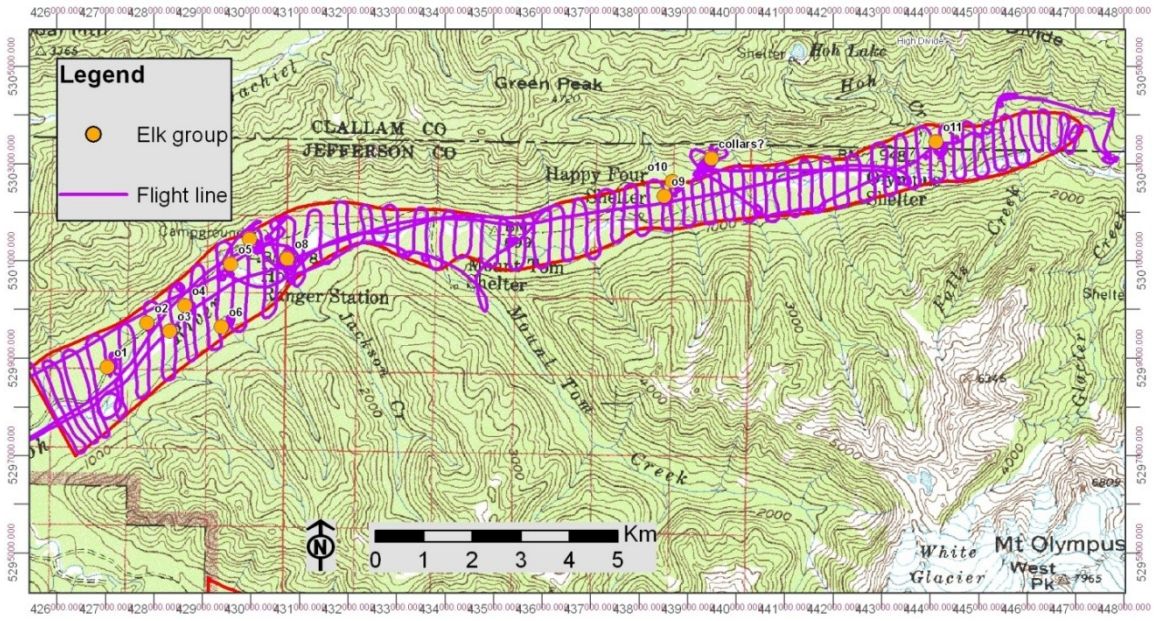

Figure 9. Flight line (purple) in the Hoh trend count area (red boundary line), conducted March 20, 2010. Approximate locations of observed elk groups are indicated as orange circles.

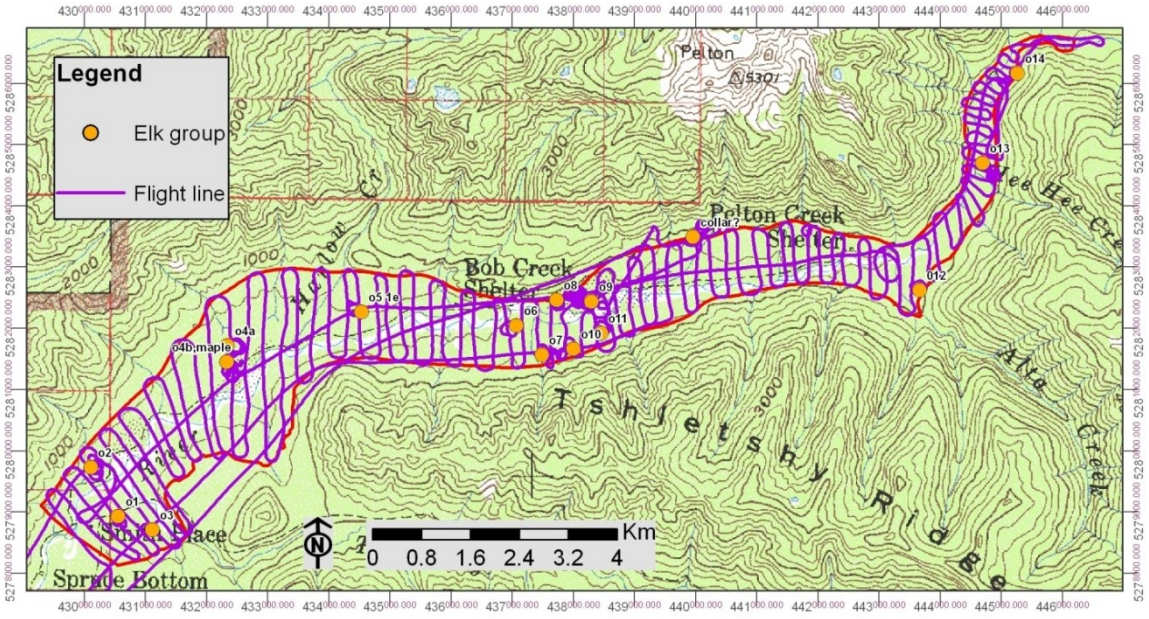

Figure 10. Flight line (purple) in the Queets trend count area (red boundary line), conducted March 24, 2010. Approximate locations of observed elk groups are indicated as orange circles.

Table 5. Summarized elk observations from spring OLYM surveys of the South fork Hoh, Hoh, and Queets trend count areas.

Trend Count Area	Groups	Total Elk	Mean Group Size	Max. Group Size
South Fork Hoh	2	27	13.5	20
Hoh	11	137	12.5	28
Queets	12	131	10.9	61

Elk Abundance and Composition Estimates

It is not yet possible to present estimated abundance or composition values for summer surveys, or abundance estimates for spring surveys. Double-observer sightability model for MORA summer surveys is still in review and neither the OLYM summer nor OLYM spring survey models has yet been developed for OLYM surveys.

Elk Captured in OLYM

The helicopter and crew arrived in Port Angeles on September 19. Capture operations took place from September 20 to 24. Eighteen elk were captured and fitted with radio collars, 15 from the NPS and 3 from the Lower Elwha K'lallam Tribe. One of these was a recaptured elk that had been fitted with a radio collar in 2009 but whose radio collar had failed. All collars deployed in 2010 are equipped with a GPS and download data through the IRIDIUM satellite. They are scheduled to acquire 4 fixes a day at 6 hour intervals, download data at 30 hour intervals, and last for 4-5 years.

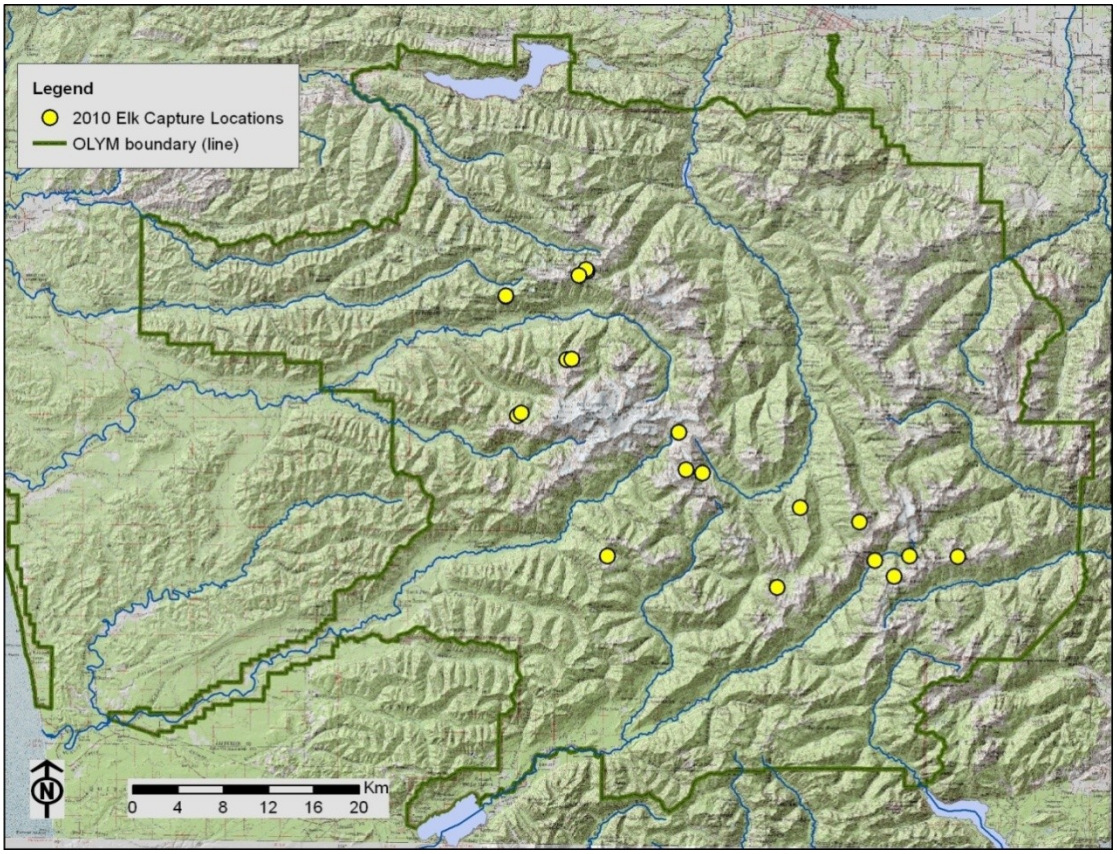

Figure 11. Map of Olympic National Park (excluding the coastal zone), showing the locations where elk were captured and fitted with a radio collar, from September 20 to 24, 2010.

Discussion

This was the third year of elk monitoring at MORA and OLYM that used the current double-observer methods for data collection (Griffin et al. in review). Summer survey methods have been refined, the protocol is in review (Griffin et al. in review), and there is a high level of cooperation between project participants at MORA. The fairly high number of radio collared elk now in OLYM (31) will be available to contribute to the double-observer sightability data set for that park.

The numbers of elk seen on the spring flights in OLYM were lower than seen in most of the past flights, especially in the South Fork Hoh (Houston et al. 1987, Jenkins et al. 1999). Fight conditions during the spring surveys in OLYM in 2010 were adequate for data collection; however the phenological conditions were just marginally in prescription. There was a cold snap with snowfall just before the surveys started that halted all spring growth. Data from the radio-equipped elk indicated that many were not in the survey frame until mid-May, after the survey window closed.

Weather for MORA surveys in 2010 was adequate. Survey crews noted that the temperatures on August 17 were higher than what is perceived to be optimal; weather during the survey was hot and sunny. The second replicate survey of the South Rainier herd trend count area was conducted over the course of three evenings, because wind gusts exceeded the speed threshold for federal flights; instead, the federally-funded portion of that survey was conducted several days after the PTOI-funded portion of the survey.

We were not able to conduct summer surveys in OLYM in 2010 due to several factors. The helicopter was not able to arrive on September 13th as scheduled due to dealing with the aftermath of an accident earlier in the summer. By the time it arrived on 19 September the weather had deteriorated. Good flying conditions were sporadic during the week of 19-25 September and the capture crew needed 5 days to capture the target of 18 elk. Because it was critical that we deployed radio collars for model development, that was the priority. However, because some of the capture operation was funded by a donation account (Washington National Parks Fund), we were able to carry funds allocated for surveys in 2010 forward and plan to complete 3-4 surveys in 2011.

Conclusion

Elk monitoring at Mount Rainier National Park and at Olympic National Park this year was successful. Results from this year will contribute to analyses of trends in abundance and composition that will be presented in the upcoming four-year report.

The four-year report will be prepared in 2012 and will include estimates of abundance and composition for MORA summer surveys from FY08, FY09, FY10, and FY11, as well as variance estimates for those values of abundance and composition. The variance estimates will be necessary to analyze the statistical significance of any apparent trends in abundance or composition.

The four-year report will only include estimates of abundance and composition for OLYM summer surveys if the number of double-observer sightability trials recorded there in FY11 is adequate to create a double-observer sightability model for OLYM. It is more likely that double-observer sightability data will need to be collected for several years of OLYM summer surveys until the sample size is adequate to create such a model. At that time, it will be straightforward to estimate abundance and composition for OLYM survey data recorded since FY08. Similarly, abundance estimates for spring OLYM surveys will only be available once a double-observer sightability model has been developed for spring OLYM surveys.

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NPS 105/109945, 149/109945, September 2011

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